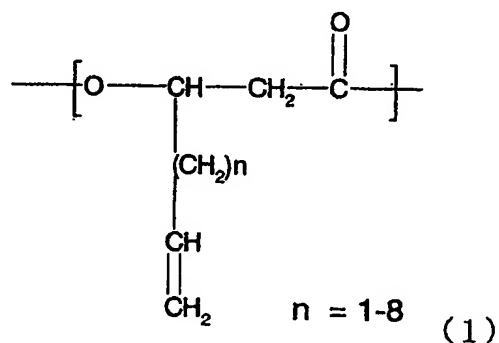


- 179 -

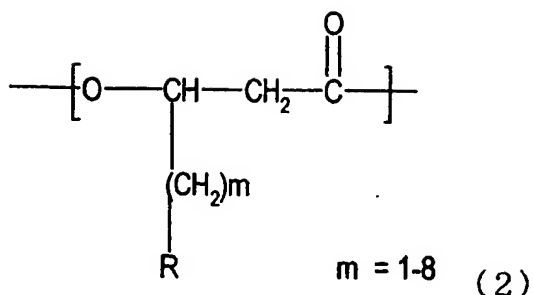
CLAIMS

1. A polyhydroxy alkanooate copolymer characterized in including at least a 3-hydroxy- ω -alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy- ω -alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule:
- 10 [Chemical Formula (1)]



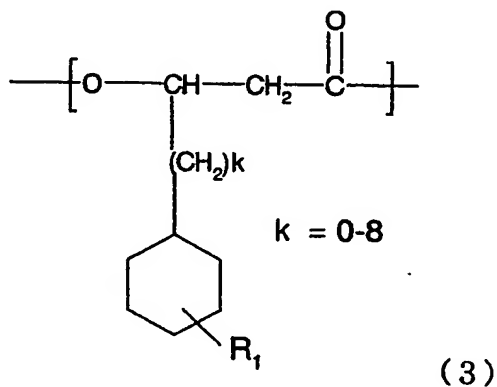
- in which n represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, n is the same or different
- 15 for each unit;
- [Chemical Formula (2)]

- 180 -



in which m represents an integer selected within a range indicated in the chemical formula; R represents a residue having any of a phenyl structure or a thienyl structure; and in case plural units are present, m and R are the same or different for each unit;

[Chemical Formula (3)]

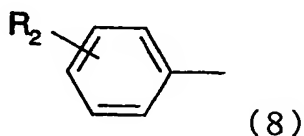


in which R₁ being a substituent on a cyclohexyl group represents a hydrogen atom, a CN group, a NO₂ group, a halogen atom, a CH₃ group, a C₂H₅ group, a C₃H₇ group, a CF₃ group, a C₂F₅ group, or a C₃F₇ group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R₁ and k may be the same or

- 181 -

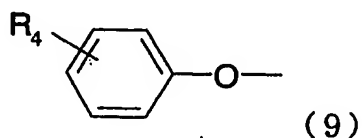
different for each unit.

2. The polyhydroxy alkanoate copolymer according to claim 1, wherein R in the chemical formula (2) represents a residue having a phenyl structure or a thienyl structure selected from the group consisting of chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):
the chemical formula (8):



10 represents a group of non-substituted or substituted phenyl groups in which R_2 , a substituent on an aromatic ring and represents an H atom, represents a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $\text{CH}=\text{CH}_2$ group, a COOR_3 group (15 R_3 represents an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

20 the chemical formula (9):

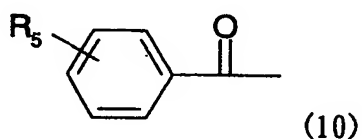


represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on

- 182 -

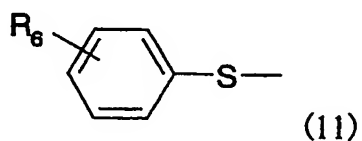
an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a CH₃ group, a C₂H₅ group, a C₃H₇ group, a SCH₃ group, a CF₃ group, a C₂F₅ group, or a C₃F₇ group; and in case plural units are present, R₄ may be the same or different for each unit;

the chemical formula (10):



represents a group of non-substituted or substituted benzoyl groups in which R₅ represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a CH₃ group, a C₂H₅ group, a C₃H₇ group, a CF₃ group, a C₂F₅ group, or a C₃F₇ group; and in case plural units are present, R₅ may be the same or different for each unit;

the chemical formula (11)

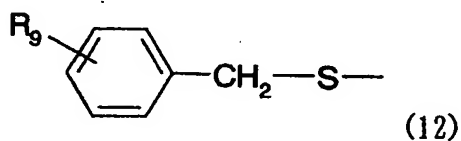


represents a group of substituted or non-substituted phenylsulfanyl groups in which R₆ represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a COOR₇

- 183 -

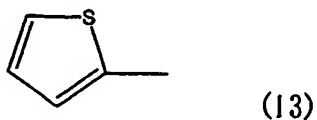
group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or
 5 a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_6 may be the same or different for each unit;

the chemical formula (12):



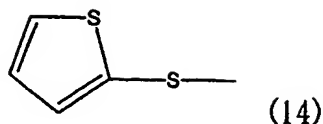
represents a group of substituted or non-substituted
 10 (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{10} group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{11} represents either
 15 one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_9 may be the same or different for each unit;

20 the chemical formula (13):



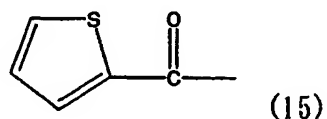
represents a 2-thienyl group;

the chemical formula (14)



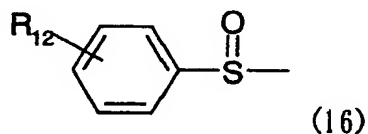
represents a 2-thienylsulfanyl group;

the chemical formula (15):



5 represents a 2-thienylcarbonyl group;

the chemical formula (16):



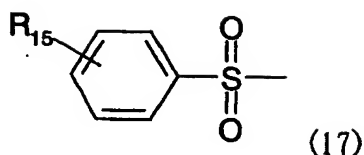
represents a group of substituted or non-substituted phenylsulfanyl groups in which R_{12} represents a

10 substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{13} group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a

15 CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_{12} may be the same or different for each unit;

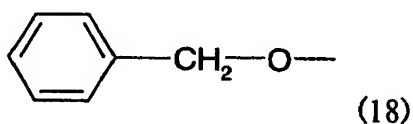
the chemical formula (17):

- 185 -



represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{16} group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{17} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_{15} may be the same or different for each unit; and

the chemical formula (18):



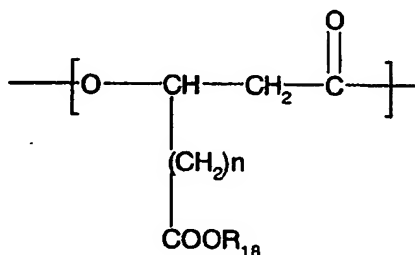
represents a (phenylmethyl)oxy group.

3. The polyhydroxy alkanoate copolymer according to claim 1, wherein a number-averaged molecular weight is within a range from 1000 to 1000000.

4. A polyhydroxy alkanoate copolymer characterized in including at least a 3-hydroxy- ω -

- 186 -

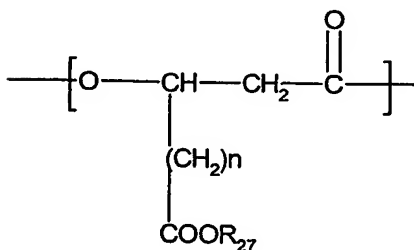
carboxyalkanoic acid unit represented by a chemical formula (19) or 3-hydroxy- ω -alkoxycarbonylalkanoic acid unit represented by a chemical formula (32) in a molecule, and simultaneously at least a 3-hydroxy- ω -alkanoic acid unit represented by a chemical formula (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, [Chemical Formula (19)]



$n = 1-8 \quad (19)$

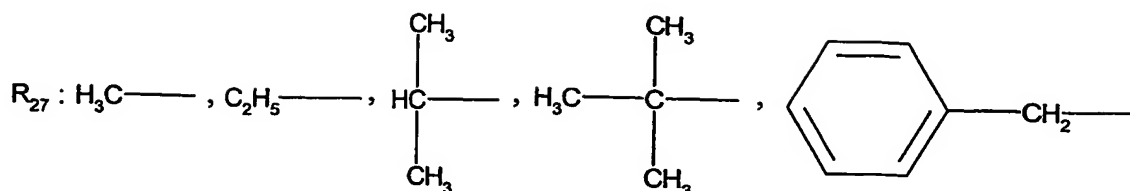
in which n represents an integer selected within a range indicated in the chemical formula; R_{18} represents an H atom, a Na atom or a K atom; and in case plural units are present, n and R_{18} may be the same or different for each unit; and

[Chemical Formula (32)]

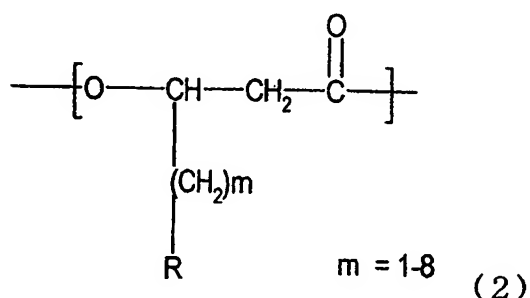


$n = 1-8 \quad (32)$

- 187 -

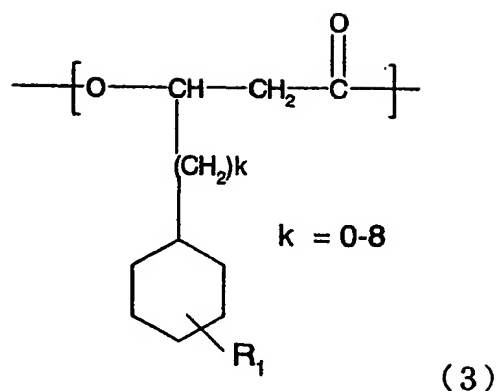


in which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} may be the same or different for each unit
 5 [Chemical Formula (2)]



in which m represents an integer selected within a range indicated in the chemical formula; R includes a residue having any of a phenyl structure or a thienyl structure; and in case plural units are present, m and R may be the same or different for each unit; and
 10 [Chemical Formula (3)]

- 188 -

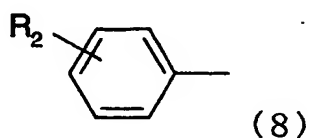


in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

10

5. The polyhydroxy alkanoate copolymer according to claim 4, wherein R in the chemical formula (2), represents a residue having a phenyl structure or a thienyl structure selected from chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17), and (18):

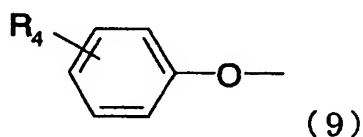
the chemical formula (8):



- 189 -

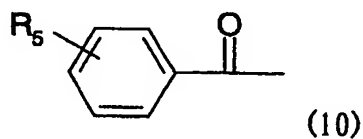
represents a group of non-substituted or substituted phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $\text{CH}=\text{CH}_2$ group, a COOR_3 group (R_3 representing an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

the chemical formula (9):



represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

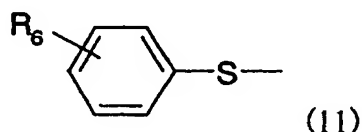


represents a group of non-substituted or substituted

- 190 -

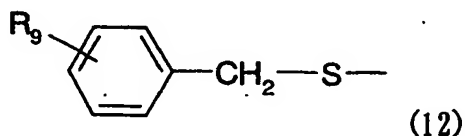
benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

the chemical formula (11):



represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_7 group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_6 is the same or different for each unit;

the chemical formula (12):



represents a group of substituted or non-substituted

- 191 -

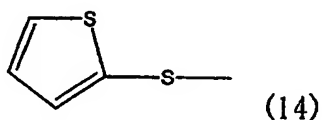
(phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{10} group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_9 is the same or different for each unit;

the chemical formula (13):



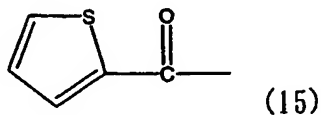
represents a 2-thienyl group;

the chemical formula (14):



represents a 2-thienylsulfanyl group;

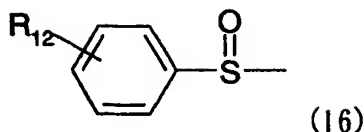
the chemical formula (15):



represents a 2-thienylcarbonyl group;

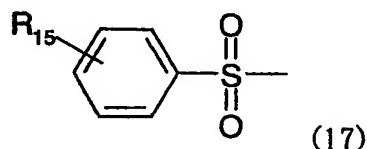
the chemical formula (16):

- 192 -



represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2-CH$ group or a $(CH_3)_3-C$ group; and in case plural units are present, R_{12} is the same or different for each unit;

the chemical formula (17):

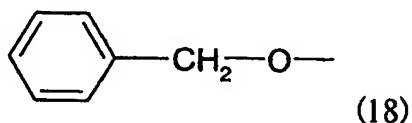


represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{16}$ group, a SO_2R_{17} group (R_{16} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{17} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2-CH$ group or a $(CH_3)_3-C$ group; and in case plural units

- 193 -

are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



5 represents a (phenylmethyl)oxy group.

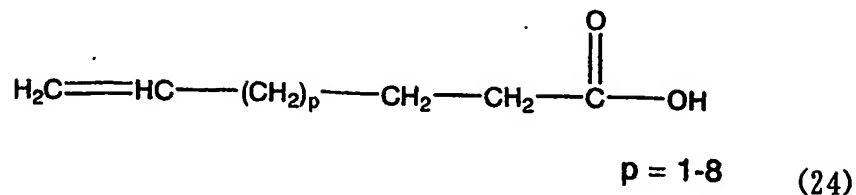
6. The polyhydroxy alkanoate copolymer according to claim 4, wherein a number-averaged molecular weight is within a range from 1000 to
10 1000000.

7. A method for producing a polyhydroxy alkanoate copolymer characterized in including a biosynthesis by a microorganism having an ability of
15 producing a polyhydroxy alkanoate copolymer including at least a 3-hydroxy- ω -alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy- ω -alkanoic acid unit represented by a chemical formula (2) or a 3-
20 hydroxy- ω -cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, from at least an ω -alkenoic acid represented by a chemical formula (24) and at least a compound represented by a chemical formula (25) or at least an ω -
25 cyclohexylalkanoic acid represented by a chemical

- 194 -

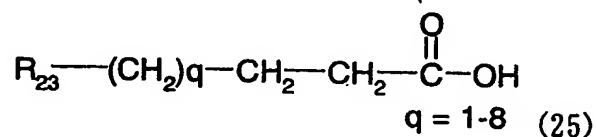
formula (26) as starting materials:

[Chemical Formula (24)]



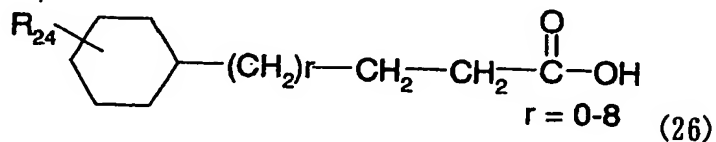
in which p represents an integer selected within a
 5 range indicated in the chemical formula;

[Chemical Formula (25)]



in which q represents an integer selected within a
 range indicated in the chemical formula; and R_{23}
 10 includes a residue having a phenyl structure or a
 thienyl structure;

[Chemical Formula (26)]

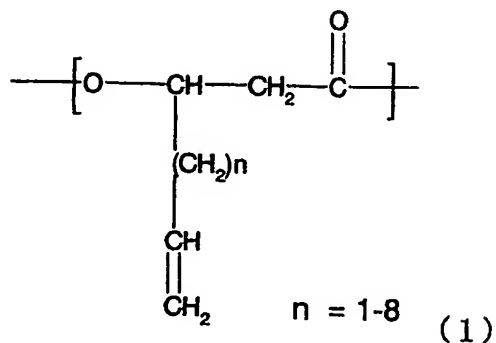


in which R_{24} represents a substituent on a cyclohexyl
 15 group and represents an H atom, a CN group, a NO_2
 group, a halogen atom, a CH_3 group, a C_2H_5 group, a
 C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group;
 and r represents an integer selected within a range

- 195 -

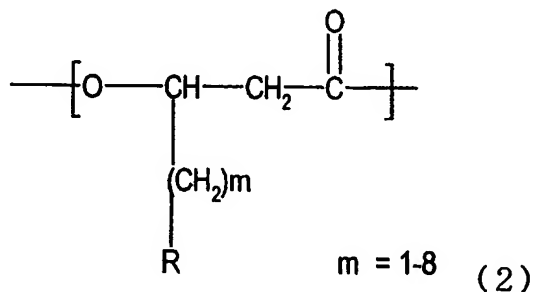
indicated in the chemical formula;

[Chemical Formula (1)]



in which n represents an integer selected within a
 5 range indicated in the chemical formula; and in case
 plural units are present, n is the same or different
 for each unit;

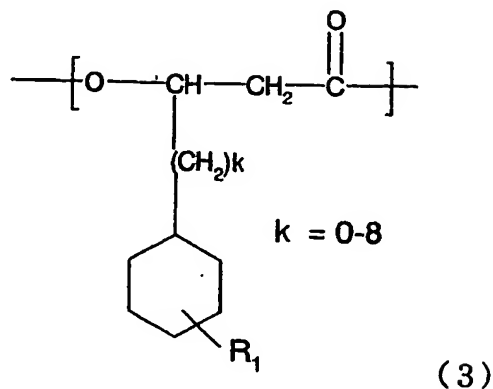
[Chemical Formula (2)]



10 in which m represents an integer selected within a
 range indicated in the chemical formula; R represents
 a residue having any of a phenyl structure or a
 thienyl structure; and in case plural units are
 present, m and R are the same or different for each
 15 unit; and

- 196 -

[Chemical Formula (3)]

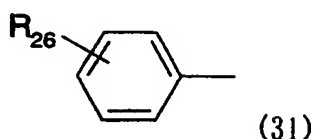


in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

8. The method for producing a polyhydroxy alkanoate copolymer according to claim 7, wherein R_{23} in the chemical formula (25) and R in the chemical formula (2), each represents a residue having a phenyl structure or a thienyl structure, are selected from chemical formulas (31), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

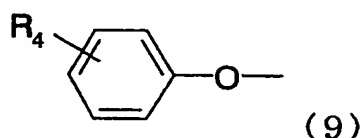
the chemical formula (31):

- 197 -



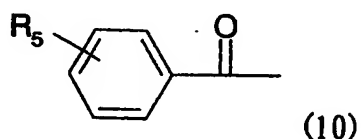
represents a group of substituted or non-substituted phenyl groups in which R_{26} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a C_2F_5 group or a C_3F_7 group; and in case plural units are present, R_{26} is the same or different for each unit;

the chemical formula (9):



represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

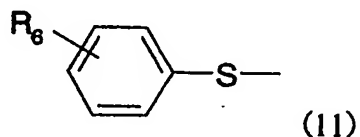


represents a group of non-substituted or substituted

- 198 -

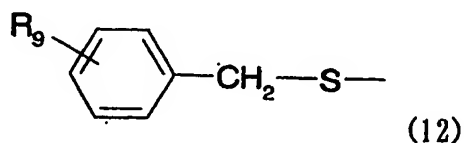
benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

the chemical formula (11):



represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_7 group, a SO_2R_8 group (R_7 representing either one of H, Na, K, CH_3 and C_2H_5 ; and R_8 representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_6 is the same or different for each unit;

the chemical formula (12):

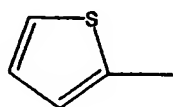


represents a group of substituted or non-substituted (benzyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H

- 199 -

atom, a halogen atom, a CN group, a NO₂ group, a COOR₁₀ group, a SO₂R₁₁ group (R₁₀ representing either one of H, Na, K, CH₃ and C₂H₅; and R₁₁ representing either one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₉ is the same or different for each unit;

the chemical formula (13):

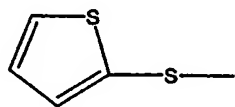


(13)

10

represents a 2-thienyl group;

the chemical formula (14):

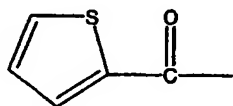


(14)

represents a 2-thienylsulfanyl group;

15

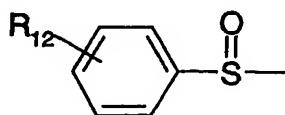
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):

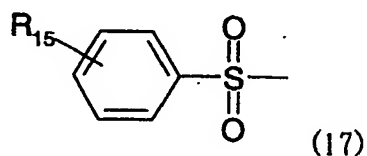


(16)

- 200 -

represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a
 5 COOR_{13} group, a SO_2R_{14} group (R_{13} representing either one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case
 10 plural units are present, R_{12} is the same or different for each unit;

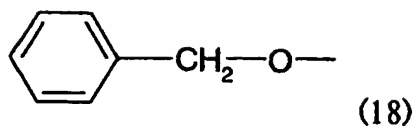
the chemical formula (17):



represents a group of substituted or non-substituted
 15 phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{16} group, a SO_2R_{17} group (R_{16} representing either one of H, Na, K, CH_3 and C_2H_5 ; and R_{17} representing
 20 either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_{15} is the same or different for each unit; and

25 the chemical formula (18):

- 201 -



represents a (phenylmethyl)oxy group.

9. The method for producing a polyhydroxy
5 alkanolate copolymer according to claim 7, wherein
said microorganism is cultured in a culture medium
including at least an ω -alkenoic acid represented by
the chemical formula (24) and at least a compound
represented by the chemical formula (25) or at least
10 an ω -cyclohexylalkanoic acid represented by the
chemical formula (26).

10. The method for producing a polyhydroxy
alkanoate copolymer according to claim 9, wherein
15 said microorganism is cultured in a culture medium
including, in addition to at least an ω -alkenoic acid
represented by the chemical formula (24) and at least
a compound represented by the chemical formula (25)
or at least an ω -cyclohexylalkanoic acid represented
20 by the chemical formula (26), at least one of a
peptide, an yeast extract, an organic acid or a salt
thereof, an amino acid or a salt thereof, a sugar, a
linear alkanolic acid with 4 to 12 carbon atoms or a
salt thereof.

25

- 202 -

11. The method for producing a polyhydroxy alkanolate copolymer according to claim 7, characterized in including a step of culturing said microorganism in a culture medium including at least
5 an ω -alkenoic acid represented by the chemical formula (24) and at least a compound represented by the chemical formula (25) or at least an ω -cyclohexylalkanoic acid represented by the chemical formula (26), and recovering a polyhydroxy alkanolate
10 copolymer including simultaneously at least a 3-hydroxy- ω -alkenoic acid unit represented by the chemical formula (1) and a 3-hydroxy- ω -alkanoic acid unit represented by the chemical formula (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit represented by
15 the chemical formula (3) in the molecule, produced by said microorganism, from cells of the microorganism.

12. The method for producing a polyhydroxy alkanolate copolymer according to claim 7, wherein
20 said microorganism is a microorganism belonging to *Pseudomonas* genus.

13. The method for producing a polyhydroxy alkanolate copolymer according to claim 12, wherein
25 said microorganism is at least one of *Pseudomonas cichorii* YN2 strain (FERM BP-7375), *Pseudomonas cichorii* H45 strain (FERM BP-7374), *Pseudomonas*

- 203 -

jessenii P161 (FERM BP-7376) and *Pseudomonas putida* P91 (FERM BP-7373).

14. A method for producing a polyhydroxy
5 alkanolate copolymer including at least a 3-hydroxy- ω -
carboxyalkanoic acid unit represented by a chemical
formula (19) in a molecule, and simultaneously at
least a 3-hydroxy- ω -alkanoic acid unit represented by
a chemical formula (2) or a 3-hydroxy- ω -
10 cyclohexylalkanoic acid unit represented by a
chemical formula (3) in the molecule comprising the
steps of:

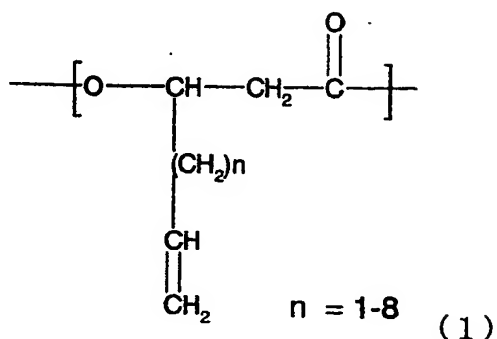
preparing a polyhydroxy alkanolate copolymer
including at least a 3-hydroxy- ω -alkenoic acid unit
15 represented by a chemical formula (1) in a molecule,
and simultaneously at least a 3-hydroxy- ω -alkanoic
acid unit represented by a chemical formula (2) or a
3-hydroxy- ω -cyclohexylalkanoic acid unit represented
by a chemical formula (3) in the molecule as a
20 starting material, and

oxidizing a double bond portion in the
polyhydroxy alkanolate represented in the chemical
formula (1) thereby generating a polyhydroxy
alkanoate copolymer including at least a 3-hydroxy- ω -
25 carboxyalkanoic acid unit represented by a chemical
formula (19) in a molecule, and simultaneously at
least a 3-hydroxy- ω -alkanoic acid unit represented by

- 204 -

a chemical formula (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule:

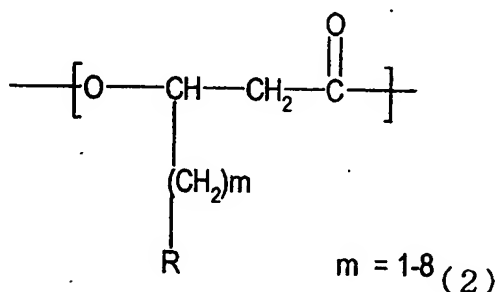
[Chemical Formula (1)]



5

in which n represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, n is the same or different for each unit;

10 [Chemical Formula (2)]

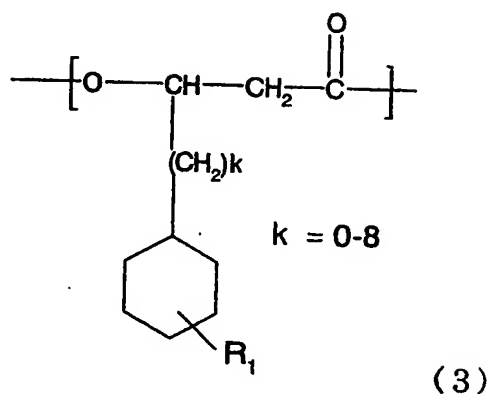


in which m represents an integer selected within a range indicated in the chemical formula; R includes a residue having any of a phenyl structure and a
 15 thienyl structure; and in case plural units are present, m and R are the same or different for each

- 205 -

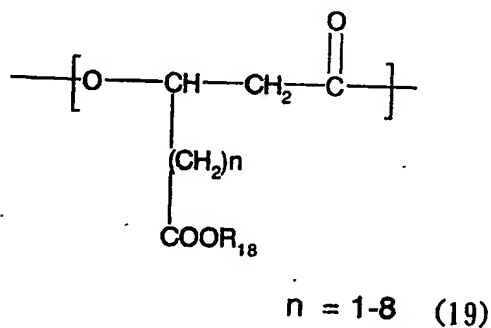
unit;

[Chemical Formula (3)]



in which R₁ represents a substituent on a cyclohexyl
 5 group selected from an H atom, a CN group, a NO₂
 group, a halogen atom, a CH₃ group, a C₂H₅ group, a
 C₃H₇ group, a CF₃ group, a C₂F₅ group, and a C₃F₇
 group; k represents an integer selected within a
 range indicated in the chemical formula; and in case
 10 plural units are present, R₁ and k are the same or
 different for each unit; and

[Chemical Formula (19)]



in which n represents an integer selected within a

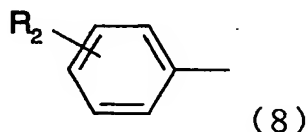
- 206 -

range indicated in the chemical formula; R_{18} represents an H atom, a Na atom, or a K atom; and in case plural units are present, n and R_{18} are the same or different for each unit.

5

15. The method for producing a polyhydroxy alkanooate copolymer according to claim 14, wherein R in the chemical formula (2) represents a residue having a phenyl structure or a thienyl structure
10 selected from chemical formulas (8), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):

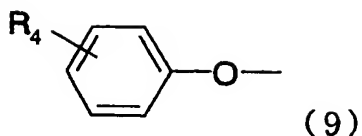
the chemical formula (8):



represents a group of non-substituted or substituted
15 phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $\text{CH}=\text{CH}_2$ group, a COOR_3 group (R_3 representing an H atom, a Na atom or a K atom), a CF_3
20 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

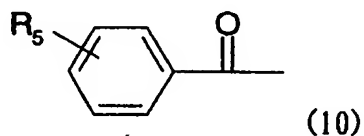
the chemical formula (9):

- 207 -



represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):

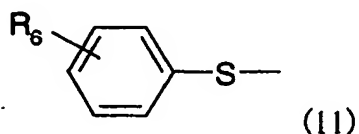


10

represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

15

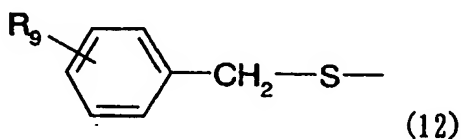
the chemical formula (11):



- 208 -

represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_7 group, a SO_2R_8 group (R_7 represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_8 represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_6 is the same or different for each unit;

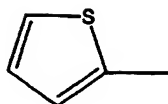
the chemical formula (12):



represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R_9 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{10} group, a SO_2R_{11} group (R_{10} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{11} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_9 is the same or different for each unit;

the chemical formula (13):

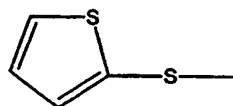
- 209 -



(13)

represents a 2-thienyl group;

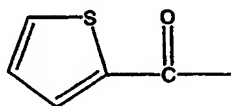
the chemical formula (14)



(14)

5 represents a 2-thienylsulfanyl group;

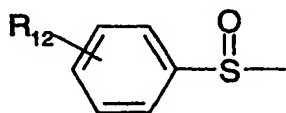
the chemical formula (15):



(15)

represents a 2-thienylcarbonyl group;

the chemical formula (16):



(16)

10

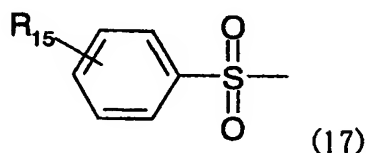
represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a

15 COOR_{13} group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a

- 210 -

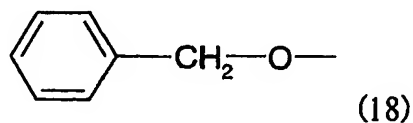
CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₁₂ is the same or different for each unit;

5 the chemical formula (17):



represents a group of substituted or non-substituted phenylsulfonyl groups in which R₁₅ represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a COOR₁₆ group, a SO₂R₁₇ group (R₁₆ represents either one of H, Na, K, CH₃ and C₂H₅; and R₁₇ represents either one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₁₅ is the same or different for each unit;

the chemical formula (18):



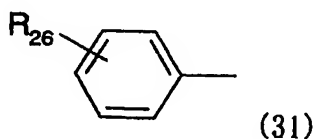
20 represents a (phenylmethyl)oxy group.

16. The method according to claim 14, wherein said starting material polyhydroxy alkanoate

- 211 -

copolymer including at least a 3-hydroxy- ω -alkenoic acid unit represented by a chemical formula (1) in a molecule, and simultaneously at least a 3-hydroxy- ω -alkanoic acid unit represented by a chemical formula
 5 (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit represented by a chemical formula (3) in the molecule, is produced by a method according to claim 7.

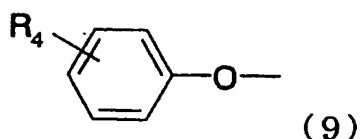
17. The method for producing a polyhydroxy
 10 alkanoate copolymer according to claim 16, wherein R in the chemical formula (2), representing a residue having a phenyl structure or a thienyl structure, is at least one of chemical formulas (31), (9), (10), (11), (12), (13), (14), (15), (16), (17) and (18):
 15 the chemical formula (31):



represents a group of substituted or non-substituted phenyl groups in which R_{26} represents a substituent on an aromatic ring and represents an H atom, a halogen
 20 atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a C_2F_5 group or a C_3F_7 group; and in case plural units are present, R_{26} is the same or different for each unit;

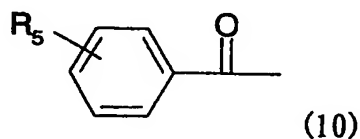
25 the chemical formula (9):

- 212 -



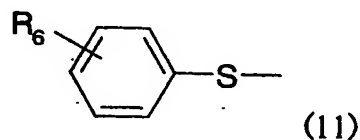
represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_4 is the same or different for each unit;

the chemical formula (10):



represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

the chemical formula (11):

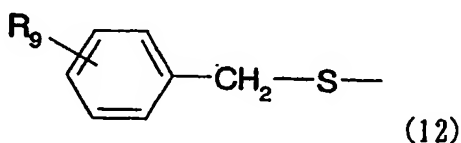


represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a

- 213 -

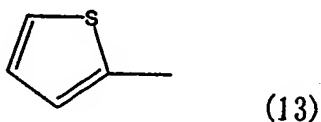
substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a COOR₇ group, a SO₂R₈ group (R₇ representing either one of H, Na, K, CH₃ and C₂H₅; and R₈ representing either one of
 5 OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₆ is the same or different for each unit;

the chemical formula (12):



10 represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R₉ represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a
 15 COOR₁₀ group, a SO₂R₁₁ group (R₁₀ representing either one of H, Na, K, CH₃ and C₂H₅; and R₁₁ representing either one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case
 20 plural units are present, R₉ is the same or different for each unit;

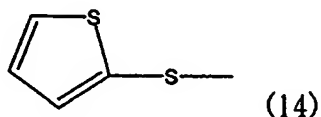
the chemical formula (13):



- 214 -

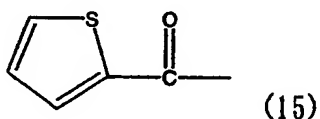
represents a 2-thienyl group;

the chemical formula (14):



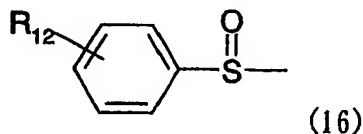
represents a 2-thienylsulfanyl group;

5 the chemical formula (15):



represents a 2-thienylcarbonyl group;

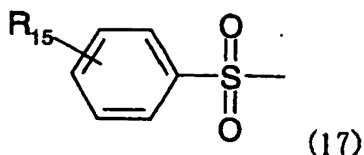
the chemical formula (16):



10 represents a group of substituted or non-substituted
phenylsulfanyl groups in which R_{12} represents a
substituent on an aromatic ring and represents an H
atom, a halogen atom, a CN group, a NO_2 group, a
COOR₁₃ group, a SO₂R₁₄ group (R_{13} representing either
15 one of H, Na, K, CH₃ and C₂H₅; and R_{14} representing
either one of OH, ONa, OK, a halogen atom, OCH₃ and
OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a
(CH₃)₂-CH group or a (CH₃)₃-C group; and in case
plural units are present, R_{12} is the same or different
20 for each unit;

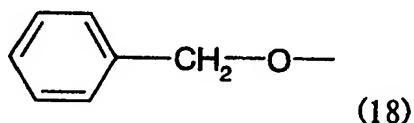
the chemical formula (17):

- 215 -



represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a COOR_{16} group, a SO_2R_{17} group (R_{16} representing either one of H, Na, K, CH_3 and C_2H_5 ; and R_{17} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present, R_{15} is the same or different for each unit; and

the chemical formula (18):



represents a (phenylmethyl)oxy group.

18. The producing method according to claim 14, wherein said oxidation reaction is carried out with an oxidant selected from a group consisting of a permanganate, a bichromate and a periodate.

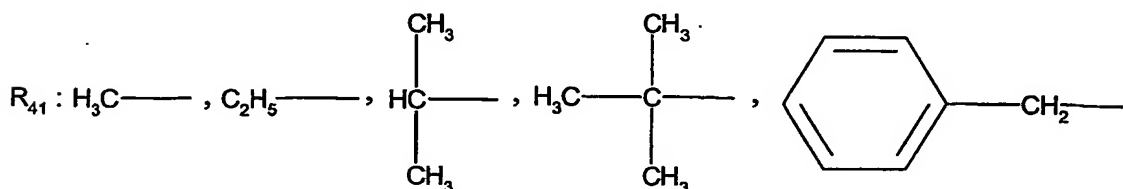
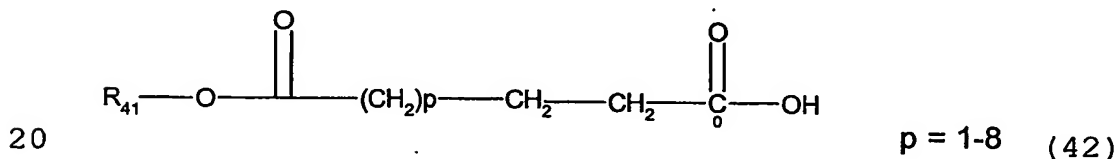
19. The producing method according to claim 18, wherein said oxidation reaction is carried out with a

- 216 -

permanganate as an oxidant and under an acidic condition.

20. The producing method according to claim 14,
5 wherein said oxidation reaction is carried out with ozone.

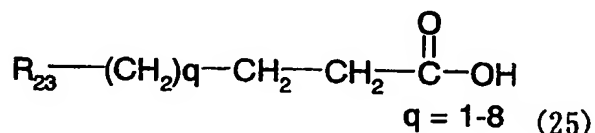
21. The method for producing a polyhydroxy
alkanoate copolymer including a biosynthesis by a
10 microorganism having an ability of producing a
polyhydroxy alkanoate copolymer including at least a
3-hydroxy- ω -alkoxycarbonylalkanoic acid unit
represented by a chemical formula (32) in a molecule,
and simultaneously at least a 3-hydroxy- ω -alkanoic
15 acid unit represented by a chemical formula (2) or a
3-hydroxy- ω -cyclohexylalkanoic acid unit represented
by a chemical formula (3) in the molecule, from a
dicarboxylic acid monoester compound represented by a
chemical formula (42):



- 217 -

in which p may assume one or more arbitrary integral values within a range indicated in the chemical formula; and R₄₁ may arbitrarily represent one or more residues indicated in the chemical formula; and at least a compound represented by a chemical formula (25) or at least a ω-cyclohexylalkanoic acid represented by a chemical formula (26) as starting materials:

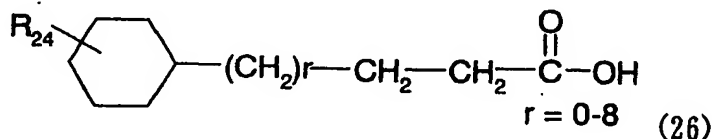
[Chemical Formula (25)]



10

in which q represents an integer selected within a range indicated in the chemical formula; and R₂₃ includes a residue having a phenyl structure or a thienyl structure;

15 [Chemical Formula (26)]



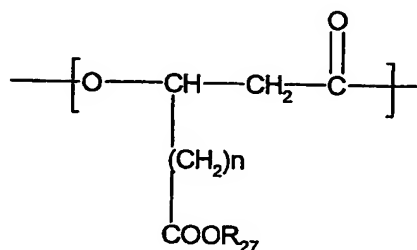
in which R₂₄ represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO₂ group, a halogen atom, a CH₃ group, a C₂H₅ group, a C₃H₇ group, a CF₃ group, a C₂F₅ group, or a C₃F₇ group; and r represents an integer selected within a range

20

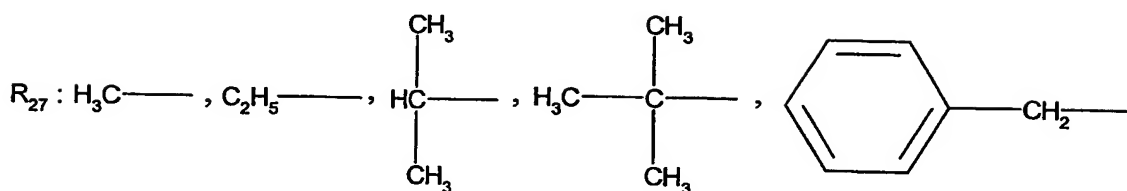
- 218 -

indicated in the chemical formula;

[Chemical Formula (32)]



$n = 1-8 \quad (32)$

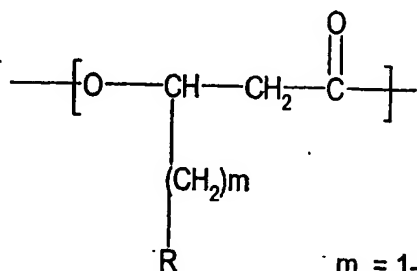


5

in which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} are the same or different for each unit;

10

[Chemical Formula (2)]



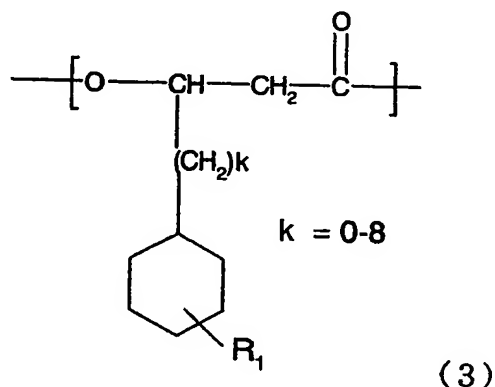
$m = 1-8 \quad (2)$

in which m represents an integer selected within a range indicated in the chemical formula; R represents

- 219 -

a residue having any of a phenyl structure and a thienyl structure; and in case plural units are present, m and R are the same or different for each unit; and

5 [Chemical Formula (3)]



in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit.

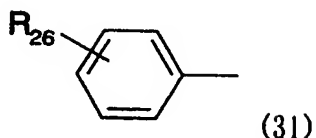
15

22. The method for producing a polyhydroxy alkanoate copolymer according to claim 21, wherein R_{23} in the chemical formula (25) and R in the chemical formula (2), each representing a residue having a phenyl structure or a thienyl structure, represents at least one of chemical formulas (31), (9), (10),

20

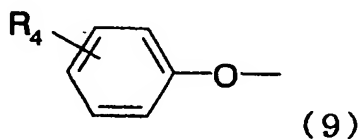
- 220 -

(11), (12), (13), (14), (15), (16), (17) and (18):
the chemical formula (31):



represents a group of substituted or non-substituted
5 phenyl groups in which R_{26} represents a substituent on
an aromatic ring and represents an H atom, a halogen
atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5
group, a C_3H_7 group, a $CH=CH_2$ group, a CF_3 group, a
 C_2F_5 group or a C_3F_7 group; and in case plural units
10 are present, R_{26} is the same or different for each
unit;

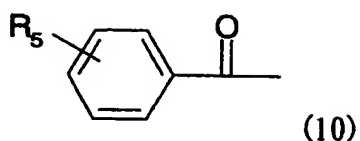
the chemical formula (9):



represents a group of non-substituted or substituted
15 phenoxy groups in which R_4 represents a substituent on
an aromatic ring and represents an H atom, a halogen
atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5
group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5
group, or a C_3F_7 group; and in case plural units are
20 present, R_4 is the same or different for each unit;

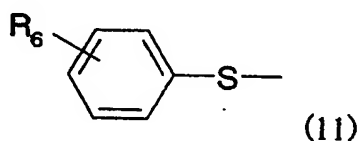
the chemical formula (10):

- 221 -



represents a group of non-substituted or substituted benzoyl groups in which R_5 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_5 is the same or different for each unit;

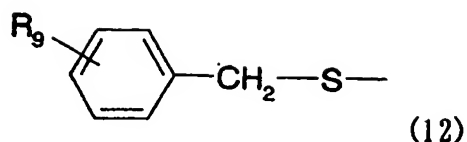
the chemical formula (11):



represents a group of substituted or non-substituted phenylsulfanyl groups in which R_6 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_7$ group, a SO_2R_8 group (R_7 representing either one of H, Na, K, CH_3 and C_2H_5 ; and R_8 representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2-CH$ group or a $(CH_3)_3-C$ group; and in case plural units are present, R_6 is the same or different for each unit;

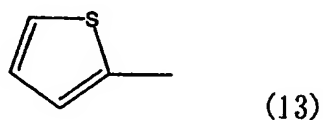
the chemical formula (12):

- 222 -



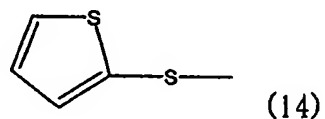
represents a group of substituted or non-substituted (phenylmethyl)sulfanyl groups in which R₉ represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a COOR₁₀ group, a SO₂R₁₁ group (R₁₀ representing either one of H, Na, K, CH₃ and C₂H₅; and R₁₁ representing either one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₉ is the same or different for each unit;

the chemical formula (13):



15 represents a 2-thienyl group;

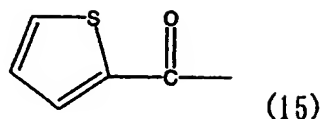
the chemical formula (14):



represents a 2-thienylsulfanyl group;

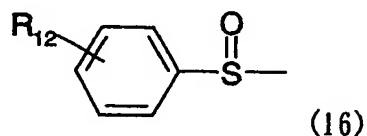
the chemical formula (15):

- 223 -



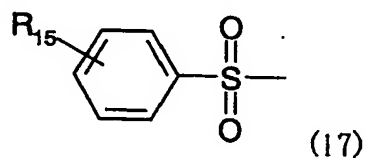
represents a 2-thienylcarbonyl group;

the chemical formula (16):



- 5 represents a group of substituted or non-substituted phenylsulfinyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} representing either
- 10 one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} representing either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2-CH$ group or a $(CH_3)_3-C$ group; and in case plural units are present, R_{12} is the same or different
- 15 for each unit;

the chemical formula (17):

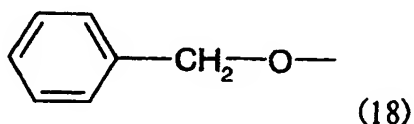


- represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a
- 20 substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a

- 224 -

COOR₁₆ group, a SO₂R₁₇ group (R₁₆ representing either one of H, Na, K, CH₃ and C₂H₅; and R₁₇ representing either one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a
5 (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₁₅ is the same or different for each unit; and

the chemical formula (18):



10 represents a (phenylmethyl)oxy group.

23. The method for producing a polyhydroxy alkanate copolymer according to claim 21, wherein the microorganism is cultured in a culture medium
15 including at least a dicarboxylic acid monoester compound represented by the chemical formula (42) and at least a compound represented by the chemical formula (25) or at least an ω-cyclohexylalkanoic acid represented by the chemical formula (26).

20

24. The method for producing a polyhydroxy alkanate copolymer according to claim 23, wherein the microorganism is cultured in a culture medium including, in addition, at least one of a peptide, an
25 yeast extract, an organic acid or a salt thereof, an

- 225 -

amino acid or a salt thereof, a sugar, a linear alkanolic acid with 4 to 12 carbon atoms or a salt thereof.

5 25. The method for producing a polyhydroxy alkanolate copolymer according to claim 21, characterized in including a step of recovering a polyhydroxy alkanolate copolymer, produced by said microorganism, from cells of the microorganism.

10

26. The method for producing a polyhydroxy alkanolate copolymer according to claim 21, wherein said microorganism is a microorganism belonging to *Pseudomonas* genus.

15

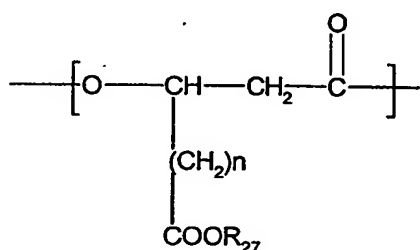
27. The method for producing a polyhydroxy alkanolate copolymer according to claim 26, wherein said microorganism is at least one of *Pseudomonas cichorii* YN2 strain (FERM BP-7375), *Pseudomonas*
20 *cichorii* H45 strain (FERM BP-7374), *Pseudomonas jessenii* P161 (FERM BP-7376) and *Pseudomonas putida* P91 (FERM BP-7373).

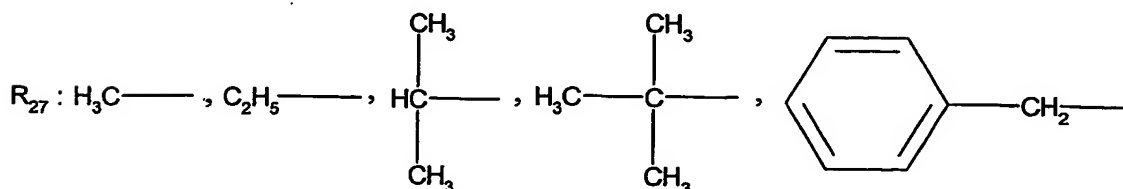
28. A method for producing a polyhydroxy
25 alkanolate copolymer, characterized in employing a polyhydroxy alkanolate copolymer including at least a 3-hydroxy- ω -alkoxycarbonylalkanoic acid unit

- 226 -

represented by a chemical formula (32) in a molecule,
 and simultaneously at least a 3-hydroxy- ω -alkanoic
 acid unit represented by a chemical formula (2) or a
 3-hydroxy- ω -cyclohexylalkanoic acid unit represented
 5 by a chemical formula (3) in the molecule as a
 starting material, and executing a hydrolysis in the
 presence of an acid or an alkali or executing a
 hydrogenolysis including a catalytic reduction,
 thereby generating a polyhydroxy alkanoate copolymer
 10 including at least a 3-hydroxy- ω -carboxyalkanoic acid
 unit represented by a chemical formula (19) in a
 molecule, and simultaneously at least a 3-hydroxy- ω -
 alkanoic acid unit represented by a chemical formula
 (2) or a 3-hydroxy- ω -cyclohexylalkanoic acid unit
 15 represented by a chemical formula (3) in the
 molecule:

[Chemical Formula (32)]

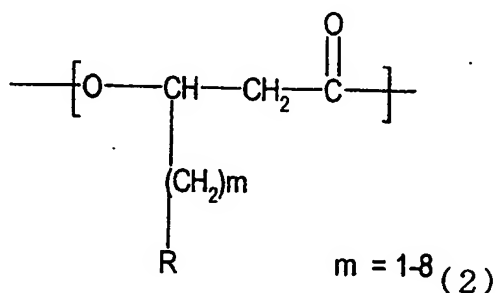


$$n = 1-8 \quad (32)$$


- 227 -

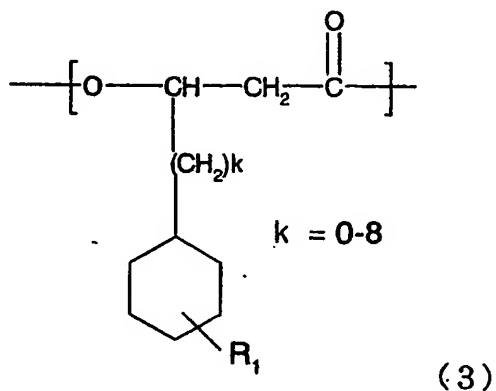
in which n represents an integer selected within a range indicated in the chemical formula; R_{27} represents any of residues indicated in the chemical formula; and in case plural units are present, n and R_{27} are the same or different for each unit;

[Chemical Formula (2)]



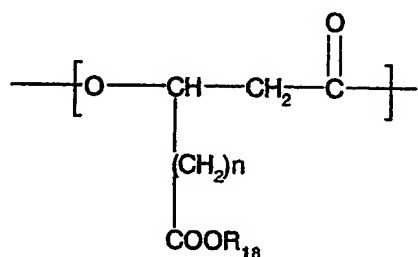
in which m represents an integer selected within a range indicated in the chemical formula; R includes a residue having any of a phenyl structure and a thienyl structure; and in case plural units are present, m and R are the same or different for each unit;

[Chemical Formula (3)]



- 228 -

in which R_1 represents a substituent on a cyclohexyl group and represents an H atom, a CN group, a NO_2 group, a halogen atom, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a C_3F_7 group;
 5 k represents an integer selected within a range indicated in the chemical formula; and in case plural units are present, R_1 and k are the same or different for each unit; and
 [Chemical Formula (19)]



$$n = 1-8 \quad (19)$$

10

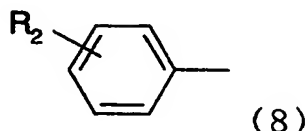
in which n represents an integer selected within a range indicated in the chemical formula; R_{18} represents an H atom, a Na atom, or a K atom; and in case plural units are present, n and R_{18} are the same
 15 or different for each unit.

29. The method for producing a polyhydroxy alkanooate copolymer according to claim 28, wherein R in the chemical formula (2), representing a residue
 20 having a phenyl structure or a thienyl structure, represents at least one of chemical formulas (8), (9),

- 229 -

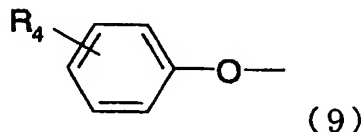
(10), (11), (12), (13), (14), (15), (16), (17) and (18):

the chemical formula (8):



5 represents a group of non-substituted or substituted phenyl groups in which R_2 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $\text{CH}=\text{CH}_2$ group, a COOR_3 group (R_3
 10 representing an H atom, a Na atom or a K atom), a CF_3 group, a C_2F_5 group, or a C_3F_7 group; and in case plural units are present, R_2 is the same or different for each unit;

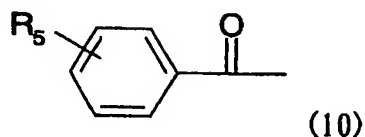
the chemical formula (9):



15 represents a group of non-substituted or substituted phenoxy groups in which R_4 represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5 group, a C_3H_7 group, a SCH_3 group, a CF_3 group, a C_2F_5
 20 group, or a C_3F_7 group; and in case plural units are

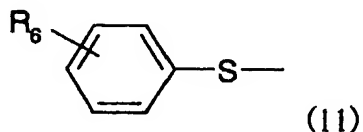
- 230 -

present, R_4 is the same or different for each unit;
the chemical formula (10):



represents a group of non-substituted or substituted
5 benzoyl groups in which R_5 represents a substituent on
an aromatic ring and represents an H atom, a halogen
atom, a CN group, a NO_2 group, a CH_3 group, a C_2H_5
group, a C_3H_7 group, a CF_3 group, a C_2F_5 group, or a
 C_3F_7 group; and in case plural units are present, R_5
10 is the same or different for each unit;

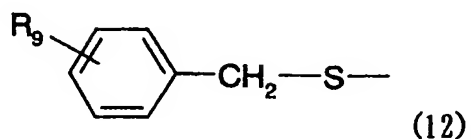
the chemical formula (11):



represents a group of substituted or non-substituted
phenylsulfanyl groups in which R_6 represents a
15 substituent on an aromatic ring and represents an H
atom, a halogen atom, a CN group, a NO_2 group, a COOR_7
group, a SO_2R_8 group (R_7 represents either one of H,
Na, K, CH_3 and C_2H_5 ; and R_8 represents either one of
OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3
20 group, a C_2H_5 group, a C_3H_7 group, a $(\text{CH}_3)_2\text{-CH}$ group or
a $(\text{CH}_3)_3\text{-C}$ group; and in case plural units are present,

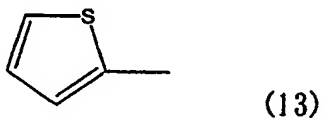
- 231 -

R₆ is the same or different for each unit;
the chemical formula (12):



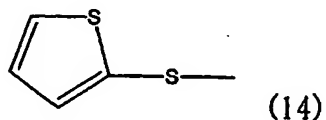
represents a group of substituted or non-substituted
5 (phenylmethyl)sulfanyl groups in which R₉ represents a
substituent on an aromatic ring and represents an H
atom, a halogen atom, a CN group, a NO₂ group, a
COOR₁₀ group, a SO₂R₁₁ group (R₁₀ represents either one
of H, Na, K, CH₃ and C₂H₅; and R₁₁ represents either
10 one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a
CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH
group or a (CH₃)₃-C group; and in case plural units
are present, R₉ is the same or different for each
unit;

15 the chemical formula (13):



represents a 2-thienyl group;

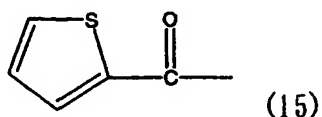
the chemical formula (14):



- 232 -

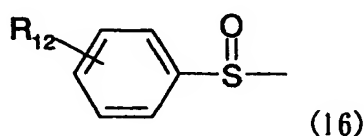
represents a 2-thienylsulfanyl group;

the chemical formula (15):



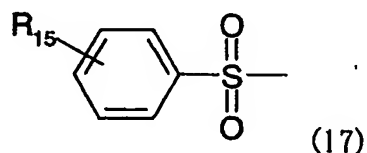
represents a 2-thienylcarbonyl group;

5 the chemical formula (16):



represents a group of substituted or non-substituted phenylsulfanyl groups in which R_{12} represents a substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO_2 group, a $COOR_{13}$ group, a SO_2R_{14} group (R_{13} represents either one of H, Na, K, CH_3 and C_2H_5 ; and R_{14} represents either one of OH, ONa, OK, a halogen atom, OCH_3 and OC_2H_5), a CH_3 group, a C_2H_5 group, a C_3H_7 group, a $(CH_3)_2-CH$ group or a $(CH_3)_3-C$ group; and in case plural units are present, R_{12} is the same or different for each unit;

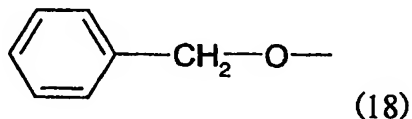
the chemical formula (17):



20 represents a group of substituted or non-substituted phenylsulfonyl groups in which R_{15} represents a

- 233 -

substituent on an aromatic ring and represents an H atom, a halogen atom, a CN group, a NO₂ group, a COOR₁₆ group, a SO₂R₁₇ group (R₁₆ represents either one of H, Na, K, CH₃ and C₂H₅; and R₁₇ represents either
5 one of OH, ONa, OK, a halogen atom, OCH₃ and OC₂H₅), a CH₃ group, a C₂H₅ group, a C₃H₇ group, a (CH₃)₂-CH group or a (CH₃)₃-C group; and in case plural units are present, R₁₅ is the same or different for each unit; and
10 the chemical formula (18):



represents a (phenylmethyl)oxy group.